CHEMICAL REACTION WHEEL

Chemical Reaction Wheel

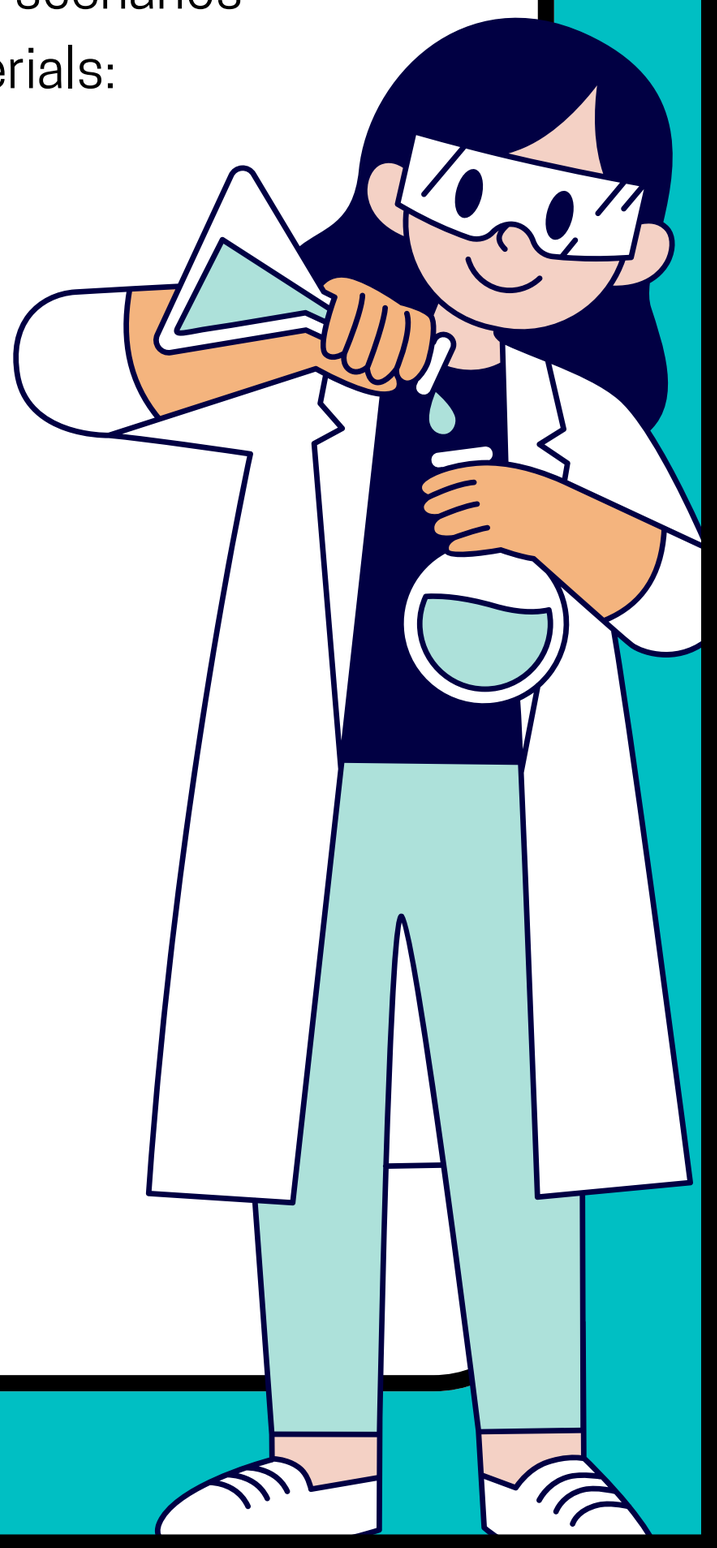
Game Theme
Types of Chemical Reaction

Grade Level
IX-X

Game Type
Board and card Game

Game Overview

- Chemical reactions are fundamental to understanding key concepts in chemistry, yet students often struggle with recognising reaction types, balancing chemical equations, and applying these reactions in real-world contexts. The 'Chemical Reaction Wheel' effectively tackles these challenges by presenting complex concepts in a dynamic and engaging format. It actively involves students in identifying real-life applications of the chemical reactions, making the learning process both interactive and practical.
- By the end of the gameplay, players will be able to classify different types of chemical reactions and recognise their applications in real-world scenarios
- A complete game set, for one group, includes the following materials:
  - 60 cards [24 cards for level 1 and 36 cards for level 3]
  - Game board
  - Pencil/spinner
  - Answer key



Gameplay Instructions

Level 1: Memory Game on Reaction Types

- This game will be played in a group of six students. The goal of this level is that students must match three cards related to one reaction type (description, chemical equation, and real-life application).
- Shuffle the 24 cards (4 cards for each of the 6 reaction types: description, chemical equation, and application). Lay the cards face down on the game board in a grid pattern.
- At the start of the game, each player chooses one of the six reaction types (e.g., combustion or neutralization).
- On each player's turn, they can flip two cards from the grid, trying to find a match that corresponds to their chosen reaction type.
- If the player finds two matching cards (e.g., reaction description and chemical equation), they keep the cards. They need to eventually collect all three cards (description, equation, and application) related to their chosen reaction.
- If the cards do not match, the player must return them to the grid face down, and the next player takes their turn.
- The first player to collect all three cards related to their chosen reaction type wins Level 1.

Level 2: Equation Completion

- The goal of level 2 is to complete partially pre-written half-reactions from various types of chemical reactions (e.g., combustion, neutralization, decomposition). Each section on the board will have a different equation, with part of it missing.
- A pencil (or spinner) is placed in the center of the board.
- Players take turns spinning the pencil. When the pencil stops, it will point to a specific section on the board that contains a partially completed chemical equation.
- The player whose turn it is must complete the half-written equation in the section where the pencil landed. Example: The section may show $CH_4 + O_2 \rightarrow ?$, and the player needs to complete it as $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$.
- If the player correctly completes the equation, they win the point and proceed to the next round.
- If the player makes a mistake, they lose their turn, and the next player spins the pencil for their chance to complete a different equation on the board.
- The player who successfully completes their assigned equation during their turn wins Level 2.
- If multiple rounds are played, the winner can be the player who completes the most equations correctly by the end of the level.

Level 3: Matching Reactions to Applications

- The goal of level 3 is that students must correctly match three chemical reactions with their corresponding real-life applications by selecting and matching cards from a set.
- There are multiple card sets, each containing 6 cards: 3 cards representing different chemical reactions and 3 cards representing corresponding real-life applications/uses of those reactions.
    - Reaction Cards: Examples of reaction types like combustion, neutralization, decomposition, etc.
    - Application Cards: Real-world applications or uses of those reactions (e.g., 'Combustion is used in engines' or 'Neutralization is used to treat acid reflux').
- Players take turns spinning the pencil. When the pencil lands on a player, that player will get to select a card set.
- The player selects one card set (containing 6 cards: 3 reactions and 3 applications) and spreads the cards out face up in front of them.
- The player must correctly match each reaction card with its corresponding application card. For example:
    - Combustion card should be matched with 'used in car engines to produce energy'
    - Neutralization card should be matched with 'used in antacids to treat stomach acidity'
    - Decomposition card should be matched with 'organic matter breaking down in composting'
- Once the player has matched all 6 cards (3 reactions and 3 applications), their answers are checked. If they are correct, the player wins the round. If not, the cards are reshuffled, and the next player takes their turn.
- The player who correctly matches all reactions with their corresponding applications during their turn wins Level 3.

Debriefing and Reflection

After the activity, guide students to reflect on:

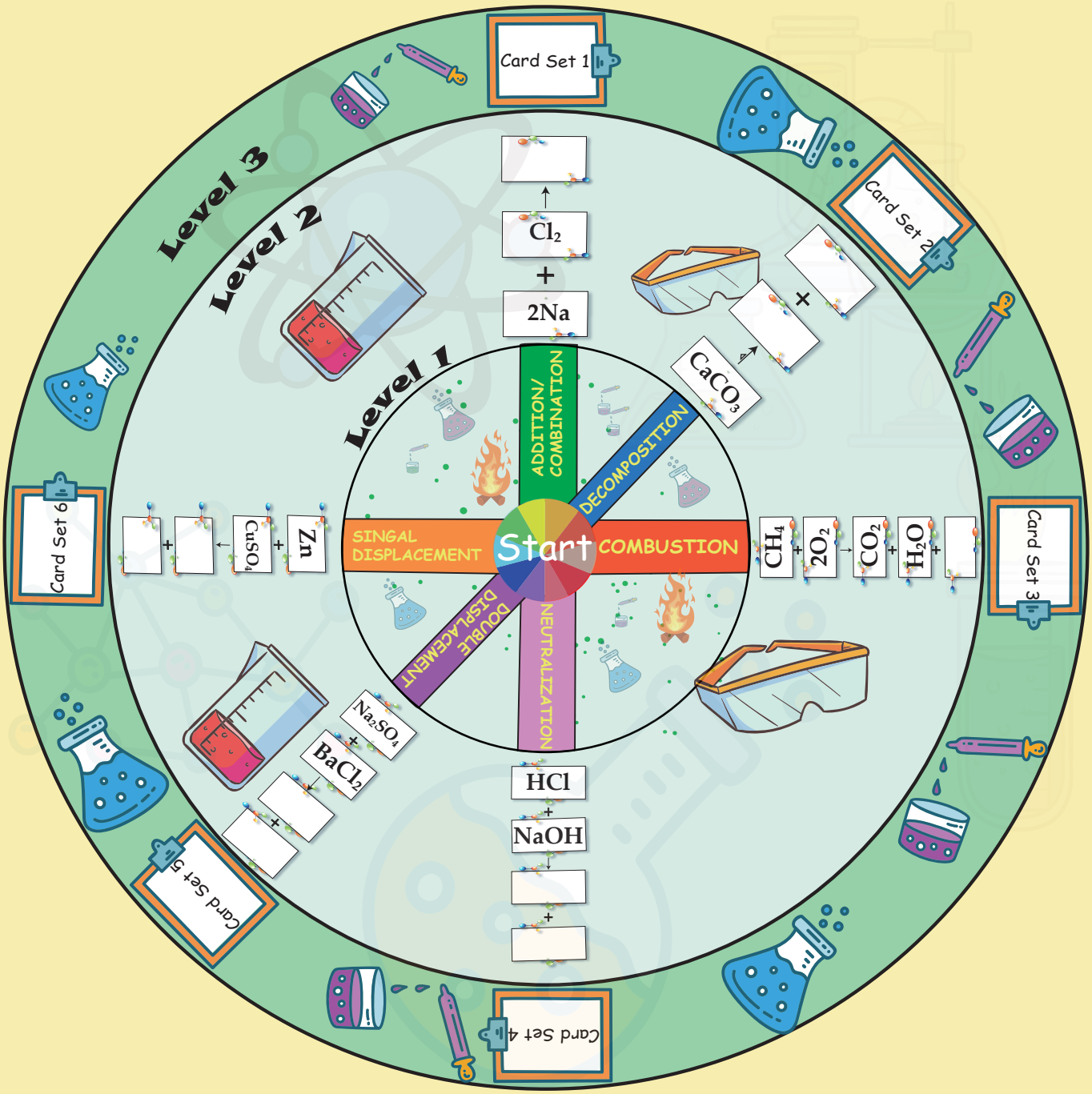
- How did this game help you differentiate between types of chemical reactions, such as combustion, neutralization, and decomposition?
- What did you learn about how chemical reactions are connected to everyday applications, like fuel combustion, medical treatments, or composting?
- Which reaction-application pair was most surprising or new to you, and how did it change your understanding of chemistry in the real world?

Adaptations for Gamplay

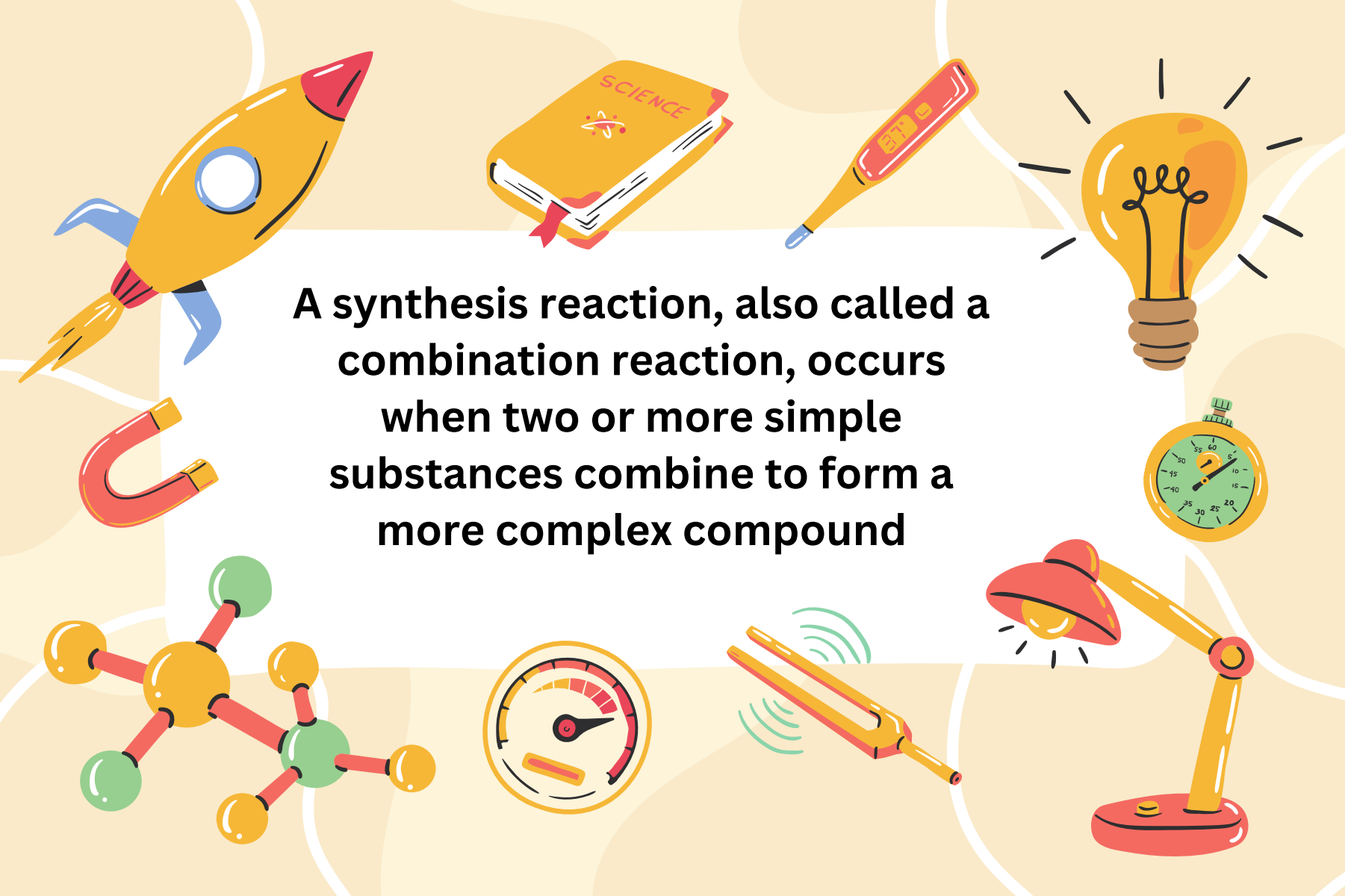
For Lower Grades: Use simpler and fewer reaction types, such as combustion and neutralization only, reducing the total number of cards. You could also provide hints, such as displaying common reactants and products around the board, so students can use these clues to complete the equations.

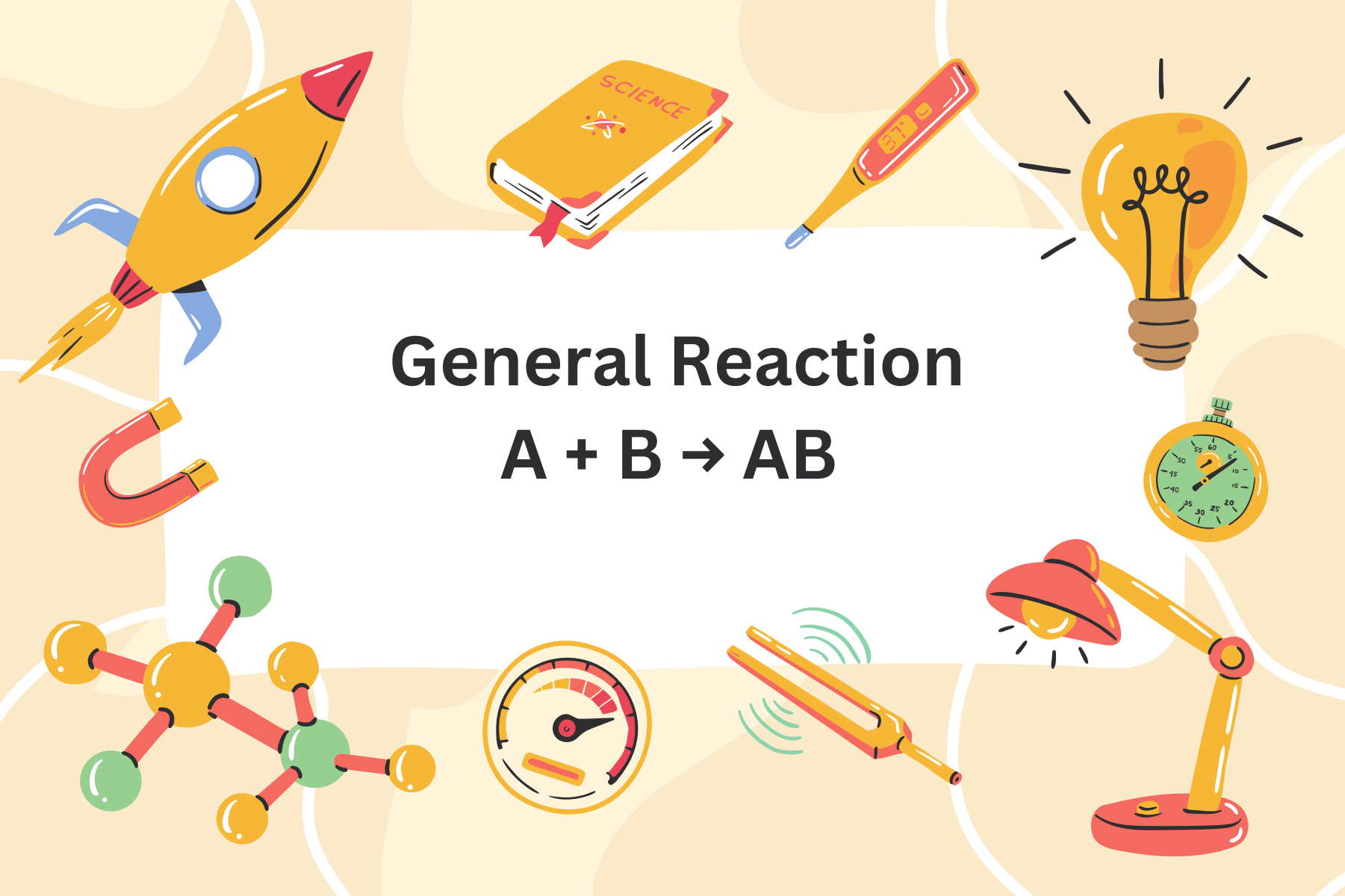
For Higher Grades: Introduce more advanced reaction types (e.g., redox reactions, synthesis, and decomposition), increasing the challenge for older students. You can also include a fourth card in each set (e.g., reaction mechanism or energy change) to deepen the understanding of the reactions.

Chemical Reaction Wheel




SCIENCE
Level 1


SCIENCE
A synthesis reaction, also called a combination reaction, occurs when two or more simple substances combine to form a more complex compound


SCIENCE
General Reaction
A + B → AB

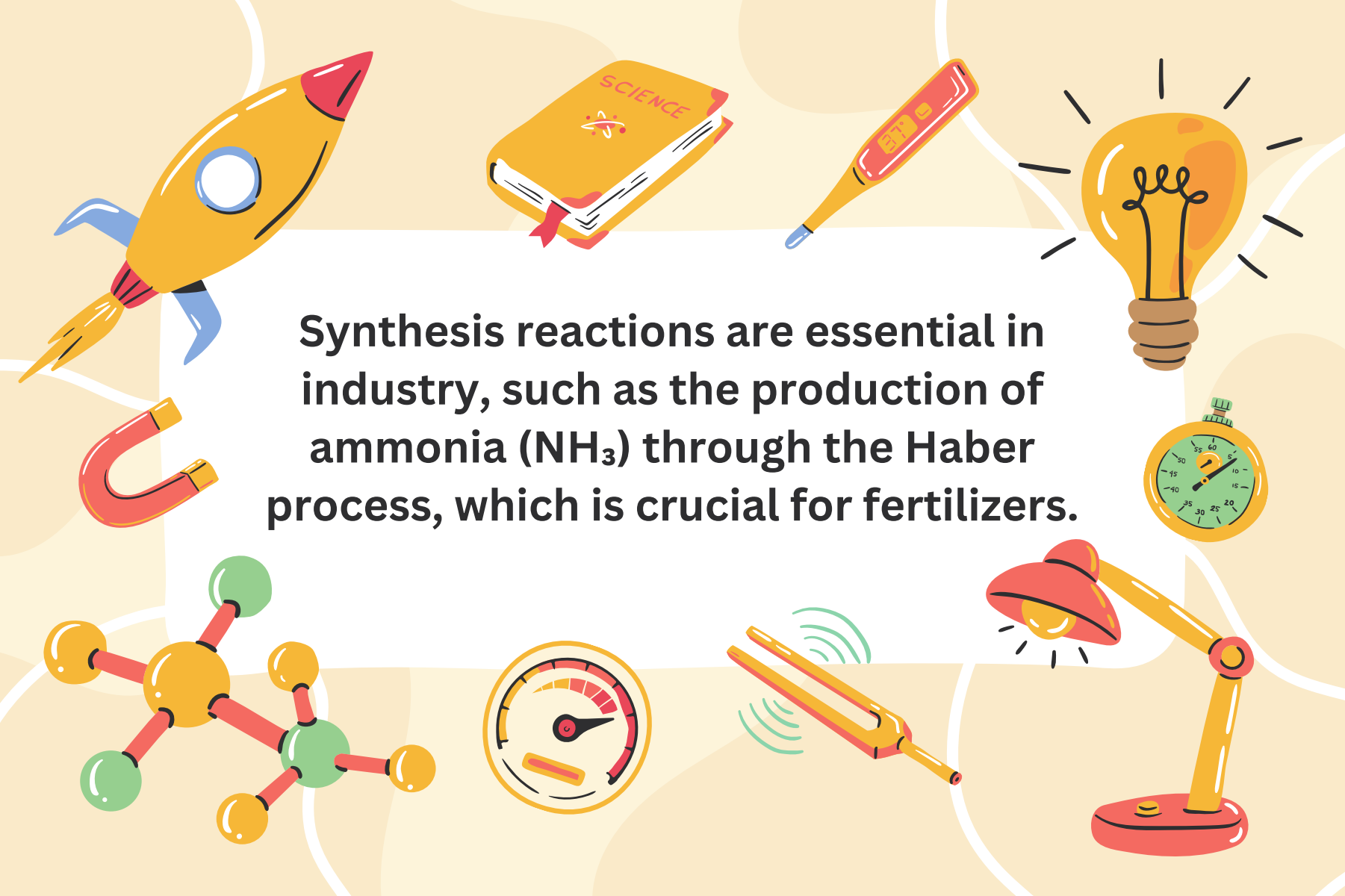


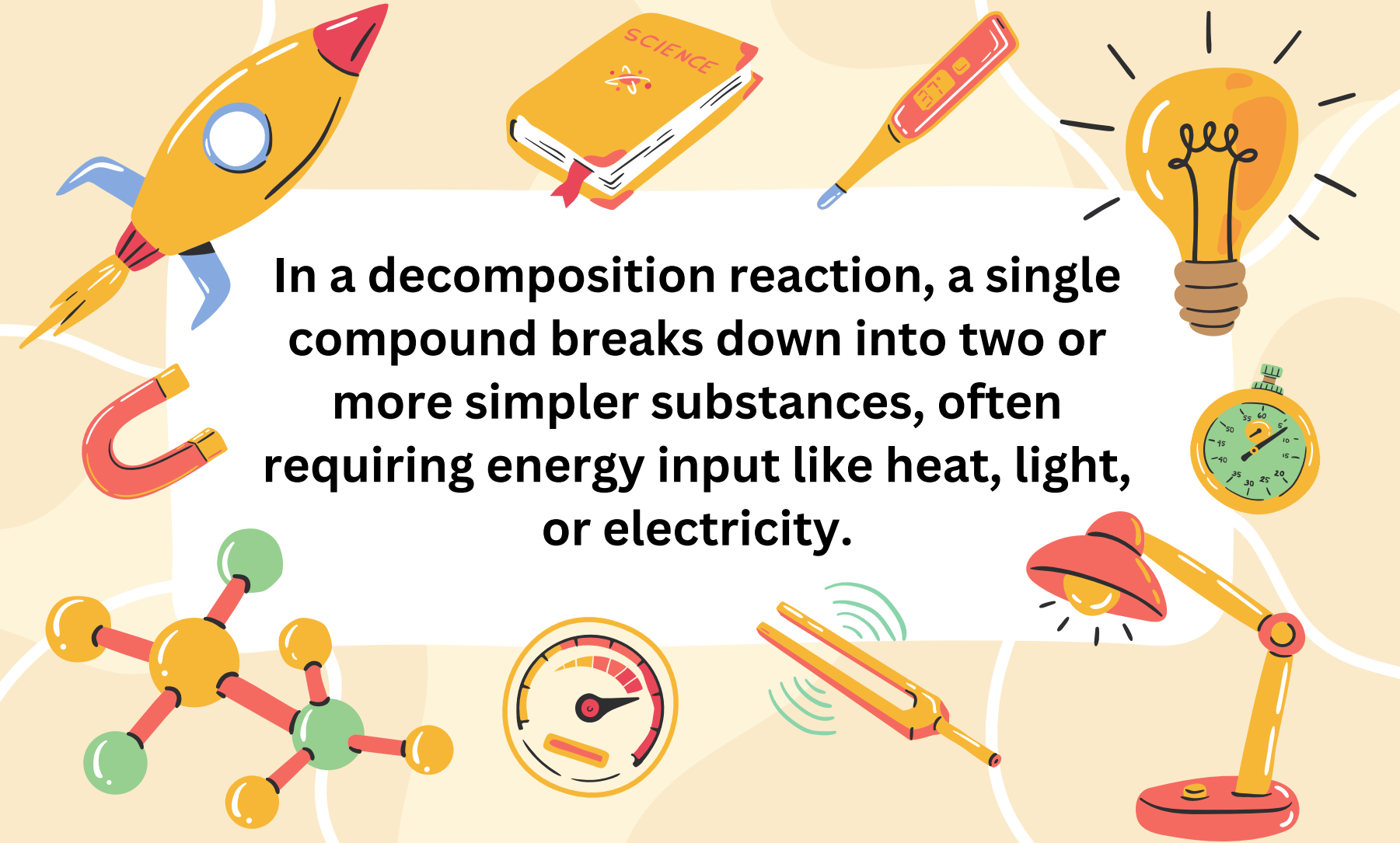
Example

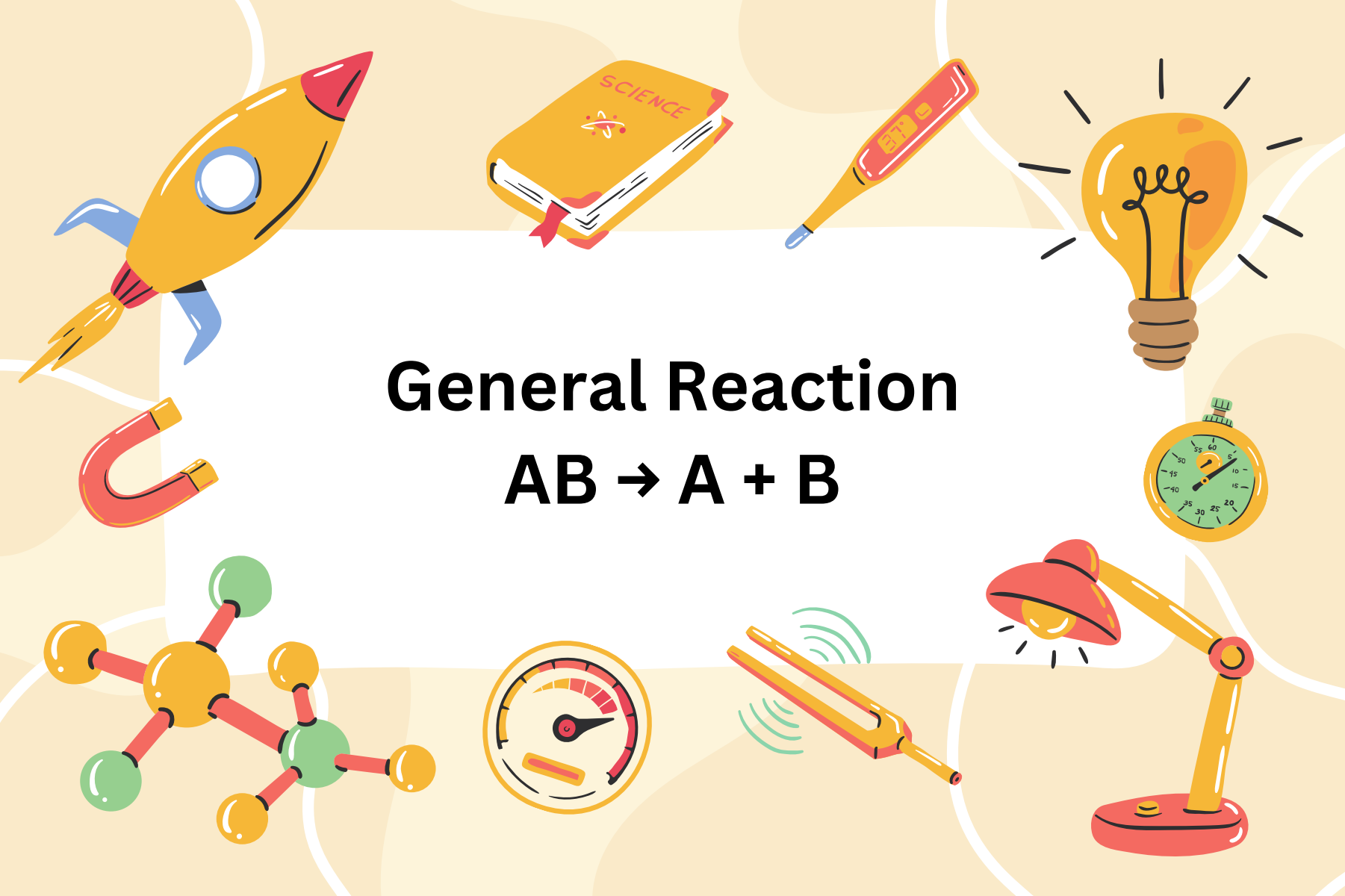
$2H_2 + O_2 \rightarrow 2H_2O$ (Hydrogen gas reacts with oxygen gas to form water






Synthesis reactions are essential in industry, such as the production of ammonia (NH_3) through the Haber process, which is crucial for fertilizers.
SCIENCE


SCIENCE
In a decomposition reaction, a single compound breaks down into two or more simpler substances, often requiring energy input like heat, light, or electricity.


SCIENCE
General Reaction
AB → A + B





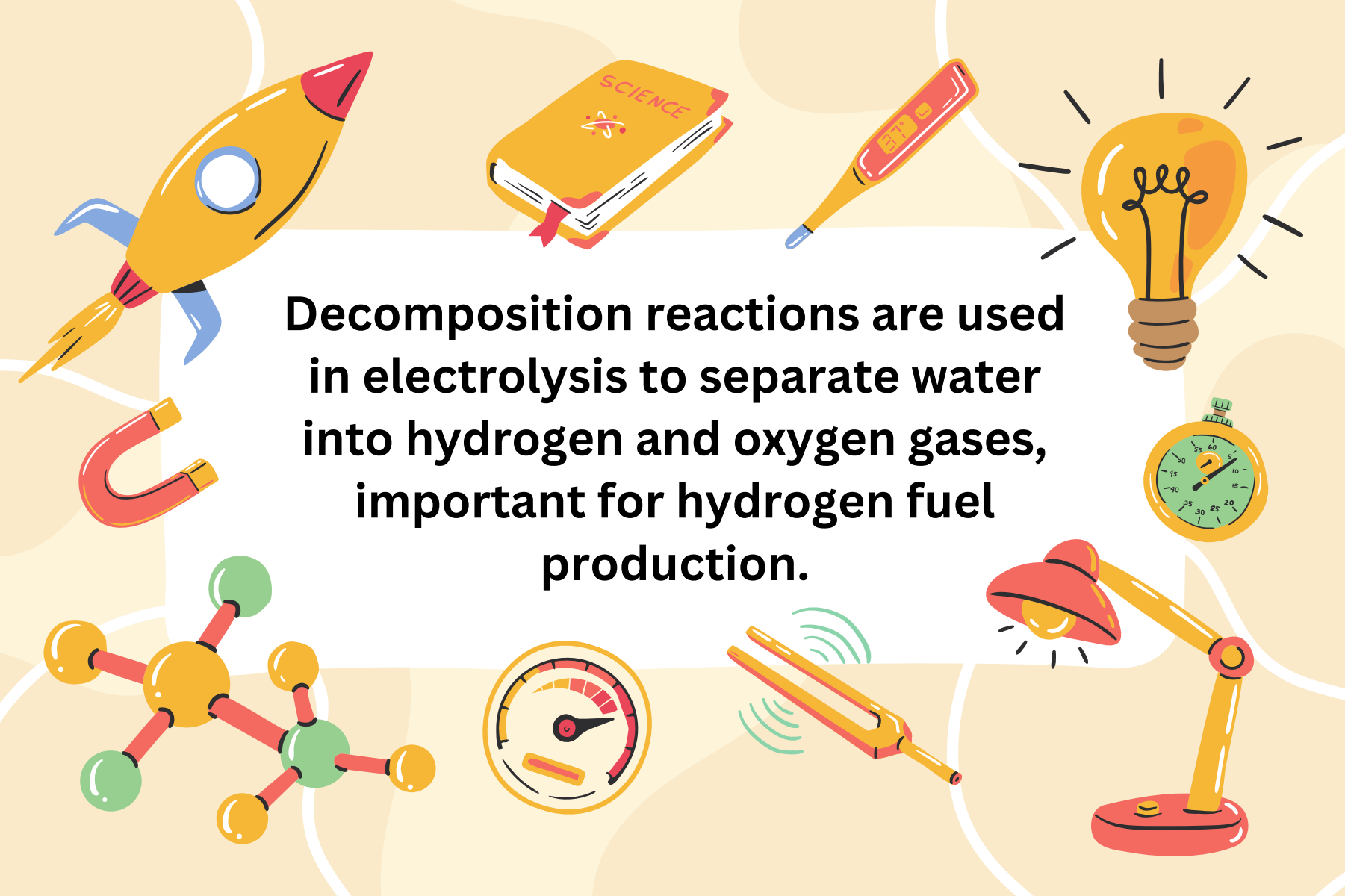


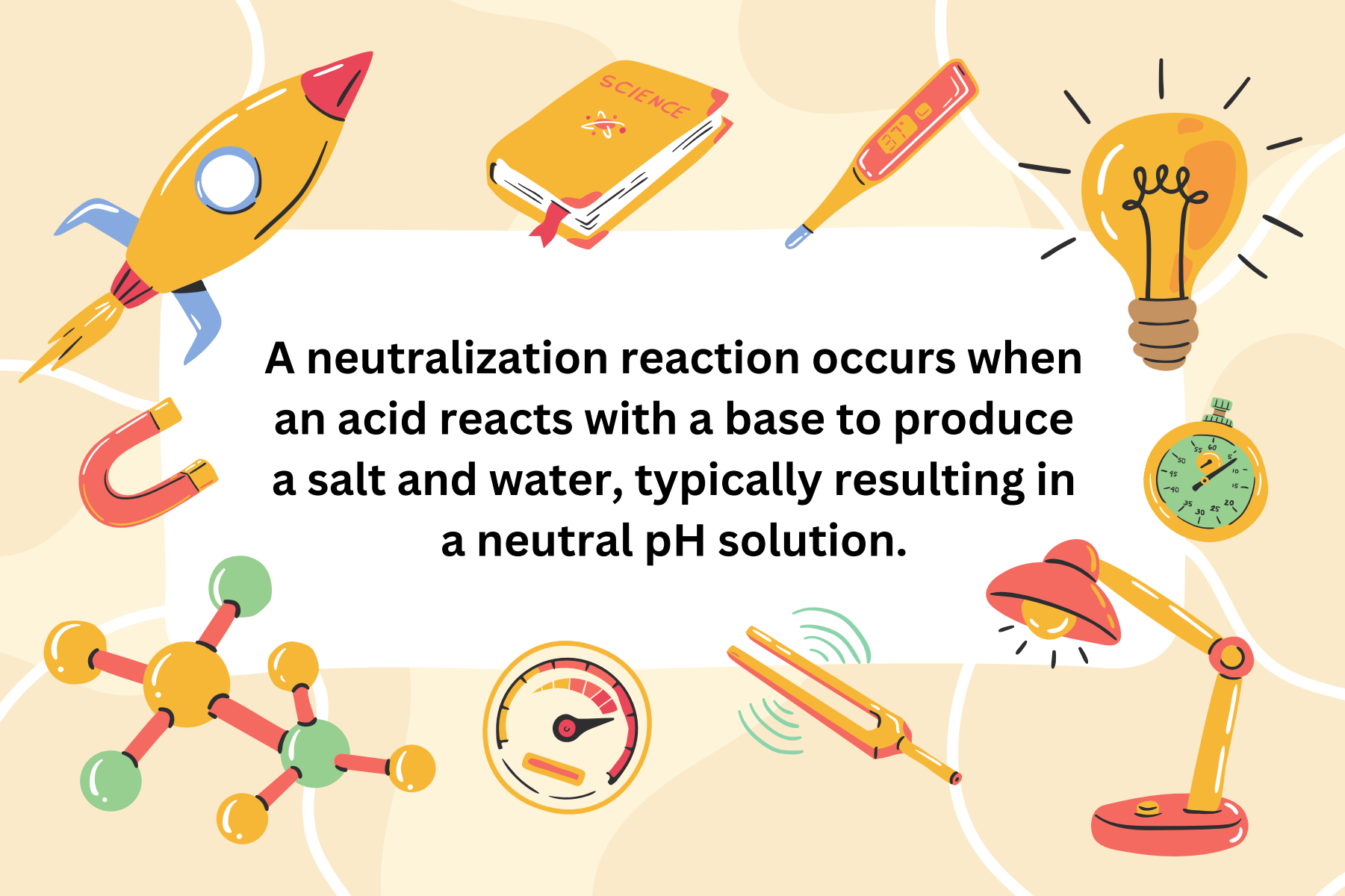


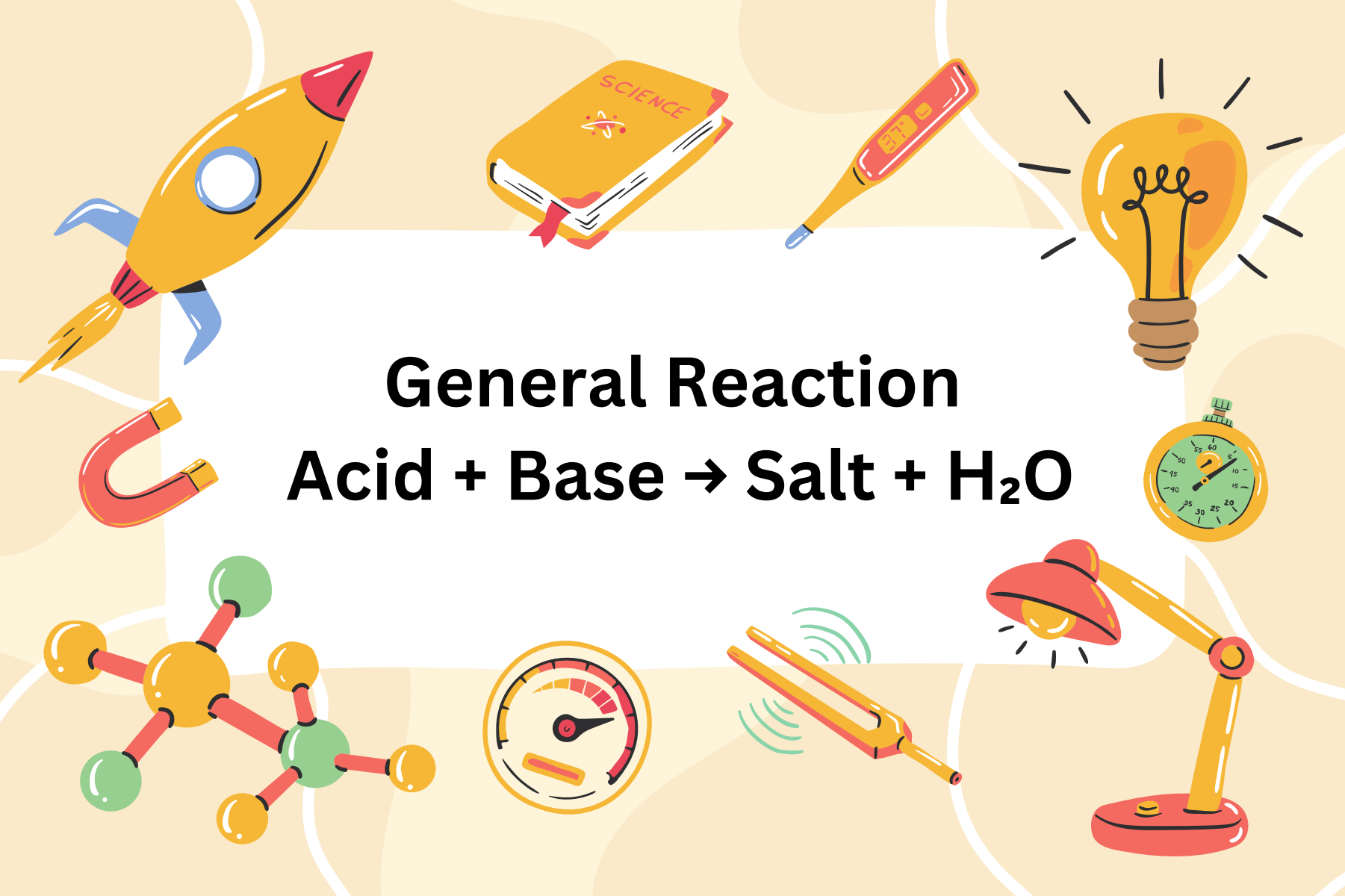
Example

$2H_2O \rightarrow 2H_2 + O_2$

(Water decomposes into hydrogen gas and oxygen gas when electrolyzed)


Decomposition reactions are used in electrolysis to separate water into hydrogen and oxygen gases, important for hydrogen fuel production.
SCIENCE


SCIENCE
A neutralization reaction occurs when an acid reacts with a base to produce a salt and water, typically resulting in a neutral pH solution.


General Reaction
Acid + Base → Salt + H_2O



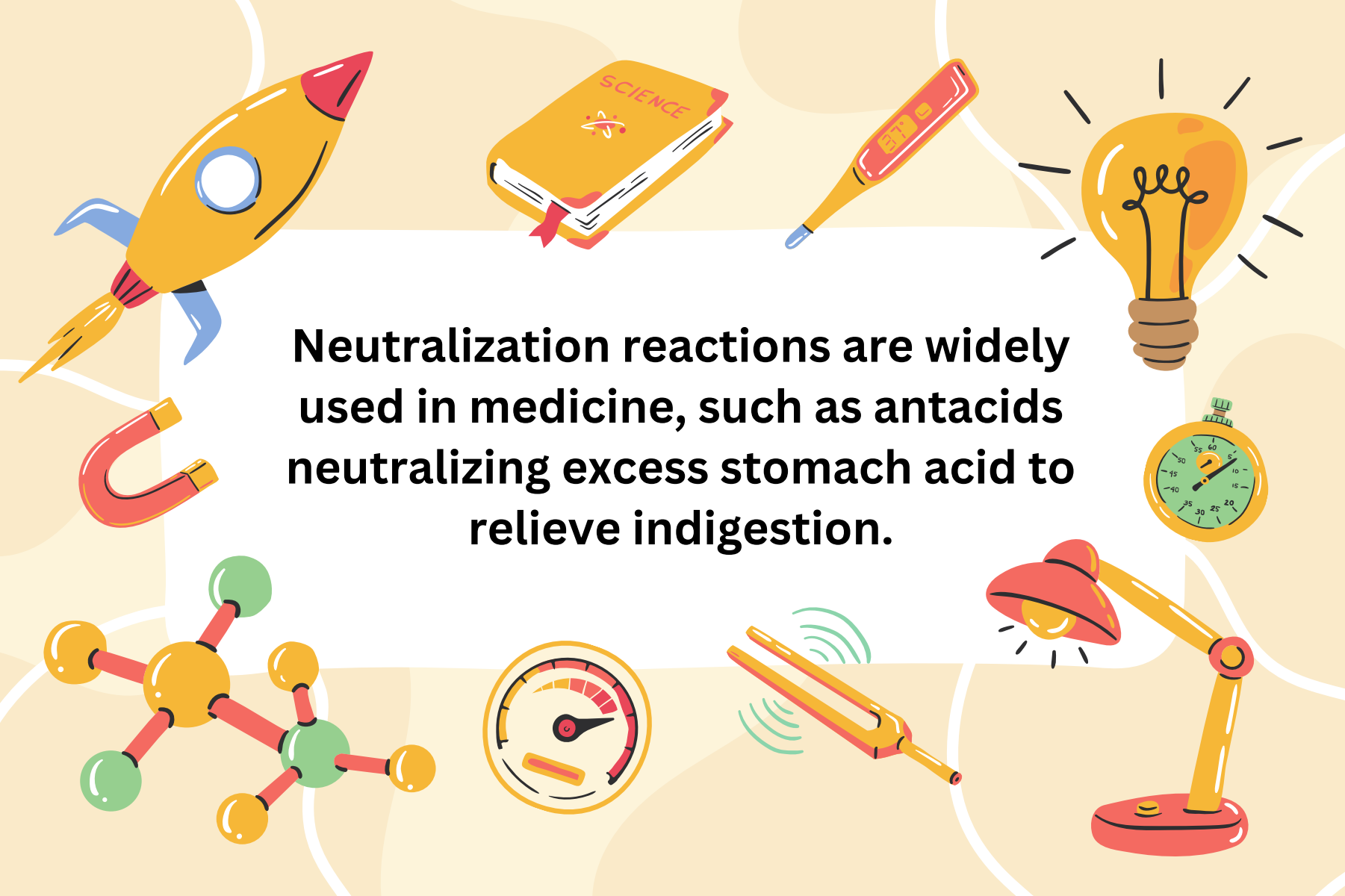

Example

$HCl + NaOH \rightarrow NaCl + H_2O$

Hydrochloric acid reacts with sodium hydroxide to form sodium chloride and water.



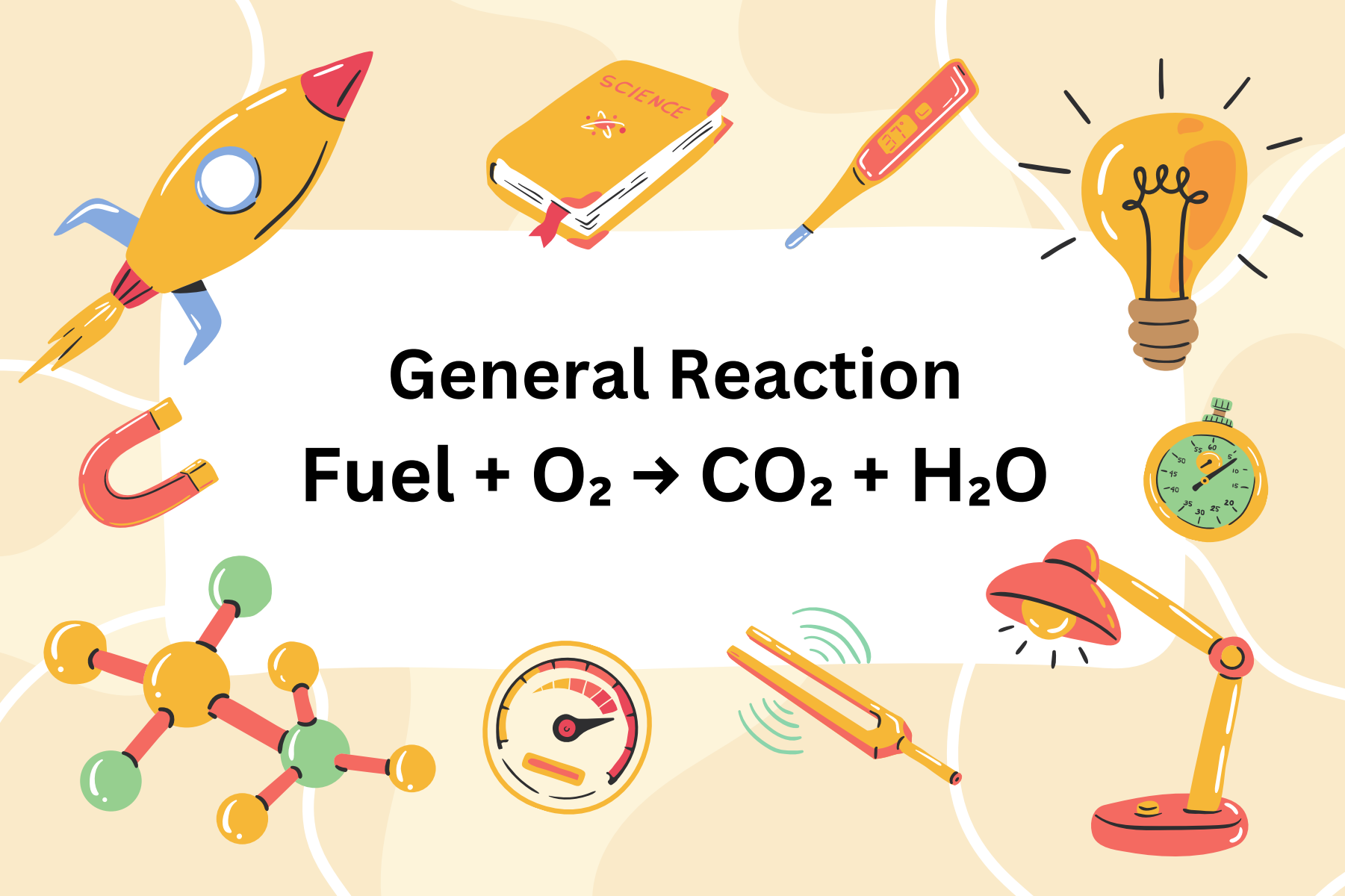



SCIENCE
Neutralization reactions are widely used in medicine, such as antacids neutralizing excess stomach acid to relieve indigestion.



A combustion reaction occurs when a substance reacts with oxygen, releasing energy in the form of heat and light, often producing carbon dioxide and water.



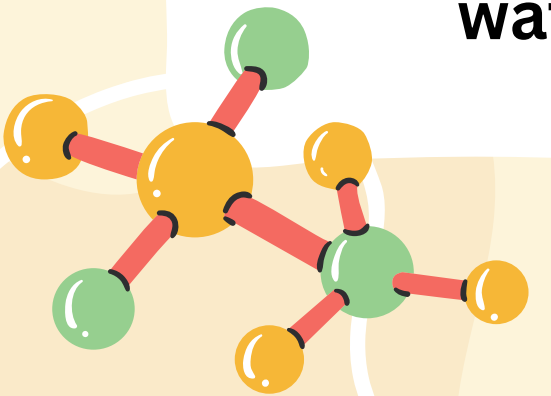


General Reaction
Fuel + O2 → CO2 + H2O




Example

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Methane reacts with oxygen to produce carbon dioxide and water, releasing energy.




Combustion reactions are key in energy production, such as in car engines and power plants, where fuels like gasoline are burned to generate mechanical or electrical energy







In a double displacement reaction, two ionic compounds exchange ions to form two new compounds, often resulting in the formation of a precipitate, water, or a gas.







General reaction

AB + CD → AD + CB







Example

$$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$$

Sodium sulfate reacts with barium chloride to form barium sulfate precipitate and sodium chloride.







Double displacement reactions are used in water purification, such as removing heavy metals from water by forming insoluble precipitates.



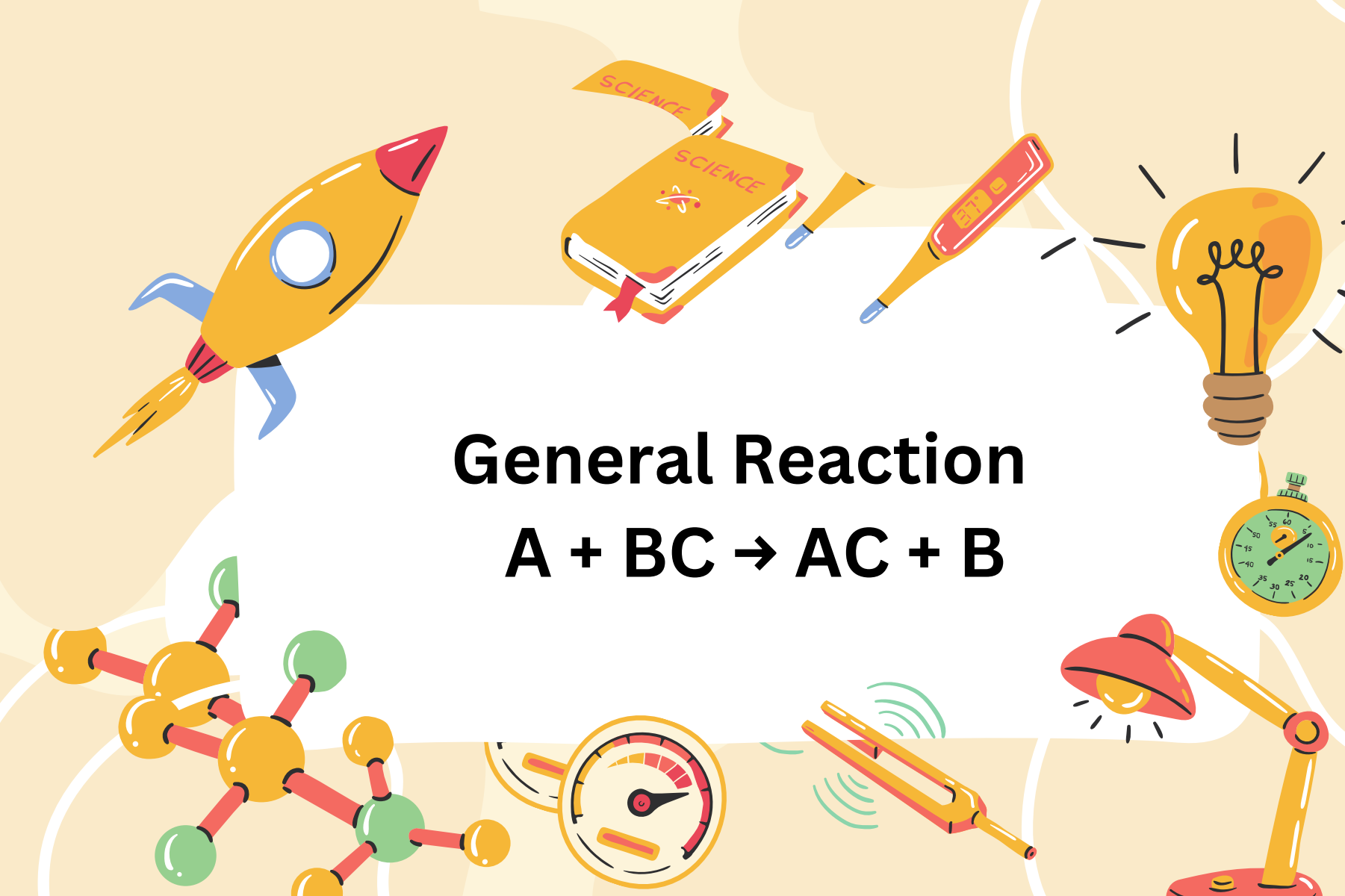




A single displacement reaction occurs when an element replaces another element in a compound, often driven by reactivity differences between metals.





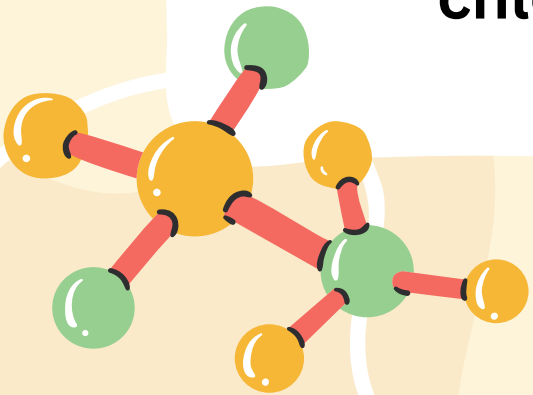

General Reaction
A + BC → AC + B



Example

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Zinc displaces hydrogen from hydrochloric acid, forming zinc chloride and hydrogen gas.




Single displacement reactions are important in metallurgy, such as extracting metals from ores (e.g., using zinc to extract copper).






SCIENCE
Level 3



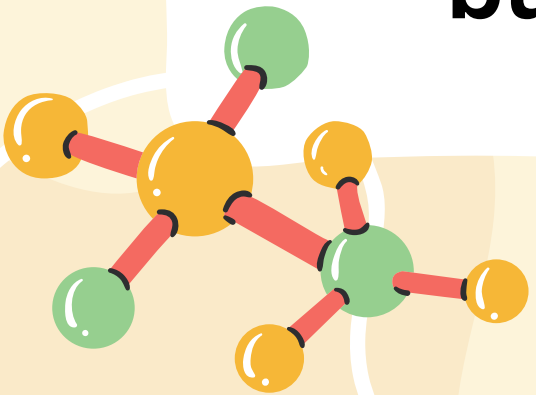
Combustion







Used in car engines to power vehicles by burning gasoline.

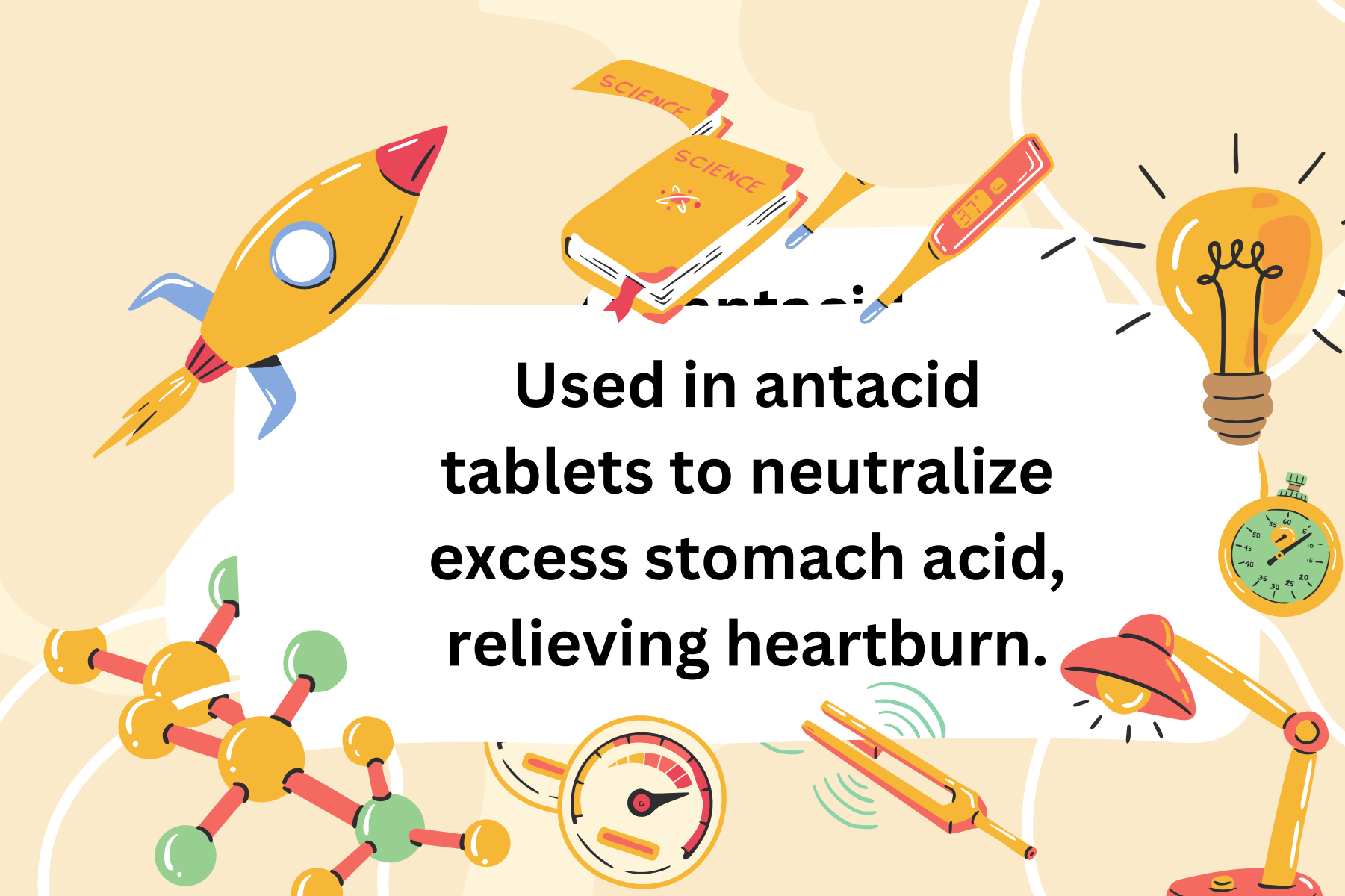






Neutralization






SCIENCE
SCIENCE
Used in antacid tablets to neutralize excess stomach acid, relieving heartburn.



Decomposition






Used in composting to break down organic matter into simpler nutrients for plants.



Single Displacement







Used in metallurgy, such as zinc replacing copper in copper sulfate to purify metals.







Synthesis (Addition)







Used in the industrial production of ammonia through the Haber process for fertilizers.







Double Displacement

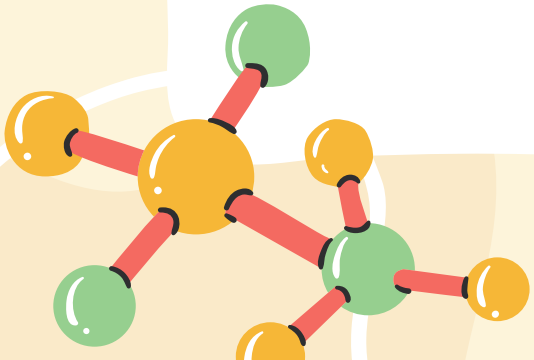


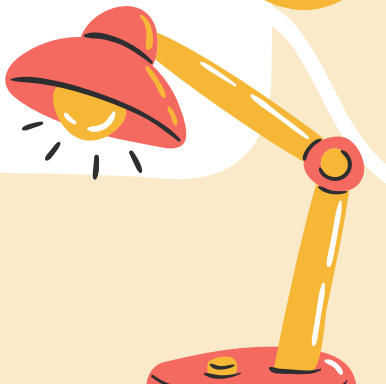


Used in wastewater treatment to remove heavy metals by forming precipitates.



Combustion



Used in power plants to generate electricity by burning fossil fuels like coal or natural gas.







Neutralization







Used to neutralize acidic soil in agriculture to create a better growing environment for crops.







Decomposition







Thermal decomposition of calcium carbonate to form lime in cement production."





Single Displacement



Used in galvanization, where zinc replaces iron on steel surfaces to prevent rusting.







Synthesis (Addition)





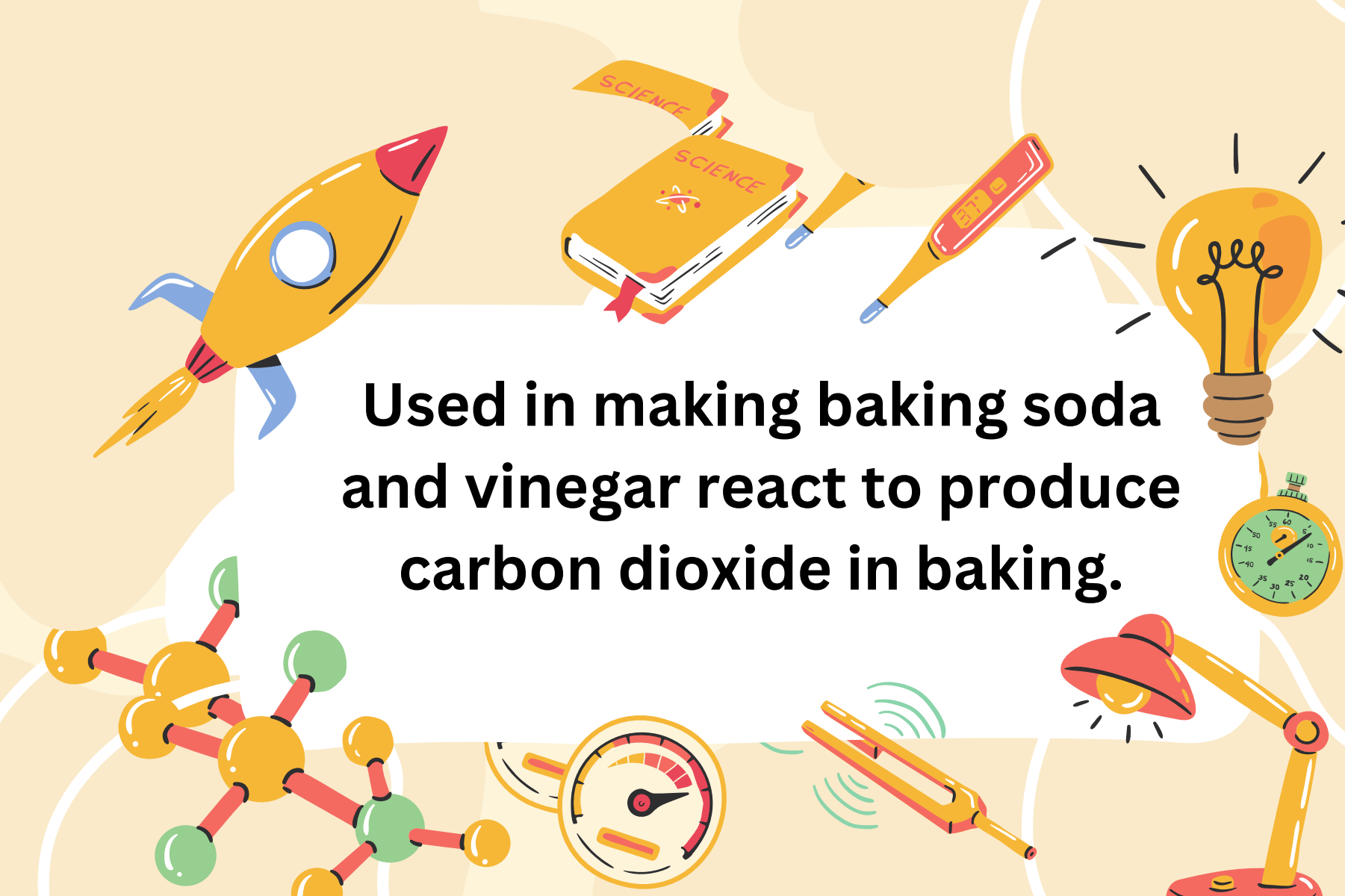


Used in forming water from hydrogen and oxygen in fuel cells to generate electricity.





Double Displacement


SCIENCE
SCIENCE
Used in making baking soda and vinegar react to produce carbon dioxide in baking.



Combustion






Used in household heating systems to burn natural gas and produce heat.



Neutralization







Used to treat industrial waste by neutralizing acids before discharge into the environment.



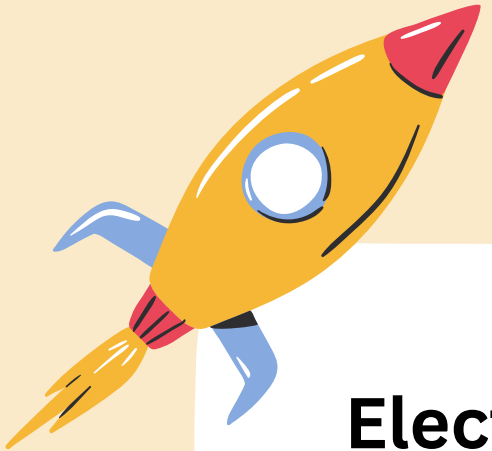




Decomposition









Electrolysis of water to produce hydrogen gas for fuel cells and oxygen gas for medical use.







Single Displacement







Used in silver tarnish removal, where aluminum displaces silver in the tarnish to restore its shine.







Synthesis (Addition)







Formation of rust, where iron reacts with oxygen to form iron oxide (rust).







Double Displacement







Used in the formation of calcium carbonate ($CaCO_3$) precipitate in water softening processes, where calcium ions react with carbonate ions to remove hardness from water.







Answer Sheet





Level 1

Synthesis (Combination) Reaction

- A synthesis reaction, also called a combination reaction, occurs when two or more simple substances combine to form a more complex compound.
- Chemical Equation Card:A + B → AB
- Example: $2H_2 + O_2 \rightarrow 2H_2O$(Hydrogen gas reacts with oxygen gas to form water.)
- Application Card - Synthesis reactions are essential in industry, such as the production of ammonia (NH_3) through the Haber process, which is crucial for fertilizers**.**

Decomposition Reaction

- In a decomposition reaction, a single compound breaks down into two or more simpler substances, often requiring energy input like heat, light, or electricity.
- Chemical Equation Card: AB → A + B
- Example: $2H_2O \rightarrow 2H_2 + O_2$(Water decomposes into hydrogen gas and oxygen gas when electrolyzed.)
- Application Card: Decomposition reactions are used in electrolysis to separate water into hydrogen and oxygen gases, important for hydrogen fuel production.

Single Displacement (Single Replacement) Reaction

- A single displacement reaction occurs when an element replaces another element in a compound, often driven by reactivity differences between metals.
- Chemical Equation Card:A + BC → AC + B
- Example: $Zn + 2HCl \rightarrow ZnCl_2 + H_2$(Zinc displaces hydrogen from hydrochloric acid, forming zinc chloride and hydrogen gas.)
- Application Card: Single displacement reactions are important in metallurgy, such as extracting metals from ores (e.g., using zinc to extract copper).

Level 1

Double Displacement (Double Replacement) Reaction

- In a double displacement reaction, two ionic compounds exchange ions to form two new compounds, often resulting in the formation of a precipitate, water, or a gas.
- Chemical Equation Card:AB + CD → AD + CB
- Example: $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$(Sodium sulfate reacts with barium chloride to form barium sulfate precipitate and sodium chloride.)
- Application Card:Double displacement reactions are used in water purification, such as removing heavy metals from water by forming insoluble precipitates.

Combustion Reaction

- A combustion reaction occurs when a substance reacts with oxygen, releasing energy in the form of heat and light, often producing carbon dioxide and water.
- Chemical Equation Card:Fuel + $O_2 \rightarrow CO_2 + H_2O$
- Example: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$(Methane reacts with oxygen to produce carbon dioxide and water, releasing energy.)
- Application Card:Combustion reactions are key in energy production, such as in car engines and power plants, where fuels like gasoline are burned to generate mechanical or electrical energy.
-

Neutralization Reaction

- A neutralization reaction occurs when an acid reacts with a base to produce a salt and water, typically resulting in a neutral pH solution.
- Chemical Equation Card:Acid + Base → Salt + H_2O
- Example: $HCl + NaOH \rightarrow NaCl + H_2O$(Hydrochloric acid reacts with sodium hydroxide to form sodium chloride and water.)
- Application Card:Neutralization reactions are widely used in medicine, such as antacids neutralizing excess stomach acid to relieve indigestion.

Level 2

Addition (synthesis) reaction: $2Na + Cl_2 \rightarrow 2NaCl$
In this reaction, sodium (Na) reacts with chlorine gas (Cl_2) to form sodium chloride (NaCl), also known as table salt.

Neutralization Reaction: $HCl + NaOH \rightarrow NaCl + H_2O$
This is a classic acid-base neutralization reaction where hydrochloric acid reacts with sodium hydroxide to form salt (sodium chloride) and water.

Decomposition Reaction: $CaCO_3 \rightarrow CaO + CO_2$
In this decomposition reaction, calcium carbonate decomposes upon heating to form calcium oxide and carbon dioxide.

Combustion Reaction: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
Methane combusts in oxygen, producing carbon dioxide and water, releasing energy in the process.

Double Displacement Reaction: $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$
Sodium sulfate reacts with barium chloride, resulting in the formation of a barium sulfate precipitate and sodium chloride in solution.

Single Displacement Reaction: $CuSO_4 + Zn \rightarrow ZnSO_4 + Cu$
Zinc displaces copper in copper sulfate to form zinc sulfate and copper.

Level 3

Card Set 1

- Combustion: Used in car engines to power vehicles by burning gasoline.
- Neutralization: Used in antacid tablets to neutralize excess stomach acid, relieving heartburn.
- Decomposition: Used in composting to break down organic matter into simpler nutrients for plants.

Card Set 2

- Single Displacement: Used in metallurgy, such as zinc replacing copper in copper sulfate to purify metals.
- Synthesis (Addition): Used in the industrial production of ammonia through the Haber process for fertilizers.
- Double Displacement: Used in wastewater treatment to remove heavy metals by forming precipitates.

Card Set 3

- Combustion: Used in power plants to generate electricity by burning fossil fuels like coal or natural gas.
- Neutralization: Used to neutralize acidic soil in agriculture to create a better growing environment for crops.
- Decomposition: Thermal decomposition of calcium carbonate to form lime in cement production.

Level 3

Card Set 4

- Single Displacement: Used in galvanization, where zinc replaces iron on steel surfaces to prevent rusting.
- Synthesis (Addition): Used in forming water from hydrogen and oxygen in fuel cells to generate electricity.
- Double Displacement: Used in making baking soda and vinegar react to produce carbon dioxide in baking.

Card Set 5

- Combustion: Used in household heating systems to burn natural gas and produce heat.
- Neutralization: Used to treat industrial waste by neutralizing acids before discharge into the environment.
- Decomposition: Electrolysis of water to produce hydrogen gas for fuel cells and oxygen gas for medical use.

Card Set 6

- Single Displacement: Used in silver tarnish removal, where aluminum displaces silver in the tarnish to restore its shine.
- Synthesis (Addition): Formation of rust, where iron reacts with oxygen to form iron oxide (rust).
- Double Displacement: Used in the formation of calcium carbonate ($CaCO_3$) precipitate in water softening processes, where calcium ions react with carbonate ions to remove hardness from water."